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A STUDY OF THE POLARIZATION PROPERTIES OF THE SURFACES OF JUPITER AND SATURN

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A STUDY OF THE POLARIZATION PROPERTIES OF THE SURFACES OF JUPITER AND SATURN

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ABSTRACT. The first results of polarimetric observations of Jupiter and Saturn are reported which were made in 1964 and 1965 at the Abastumani Astrophysical Observatory in the Georgian SSR. The polarization of integral light from the Jovian disk was low and revealed no clear dependence on phase angle. Polarization dependence on phase angle was noted in the polar regions, particularly in the South Polar Region. Polarization of the integral light from the visible disk of Saturn, as well as from individual regions, showed a clear dependence on phase angle. Higher polarization values were recorded for the South Polar Region than for the north region.

The first investigations of the polarization properties of Jupiter and Saturn belong to Lyot [1]. His observations were made in 1923-1926. Dollfus [2] was subsequently occupied with this problem. However, many questions which pertained to the polarization properties of Jupiter and Saturn remained unclear and require clarification. /38*

At the Abastumani Astrophysical Observatory of the Academy of Sciences of the Georgian SSR in autumn of 1964, systematic polarimetric observations of the planets Jupiter and Saturn were conducted on the electronic polarimeter of the system of L. V. Ksanfomaliti [3, 4], which was fixed at the prime focus of a 40-centimeter refractor with a focal length of 680 cm. The first results of observations made from September 1, 1964 to January 5, 1965 are shown below.

Jupiter

The polarization of the integral light of the entire visible disk of Jupiter remains low (from 0.10 to 0.34%) and reveals no clear dependence on phase angle (see Figure 1).

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*Numbers in the margin indicate pagination in the foreign text.

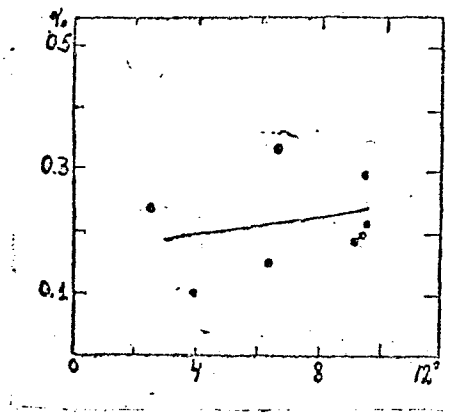

Figure 1. The Polarization of the Integral Light of the Entire Disk of Jupiter as a Function of Phase Angle, %.

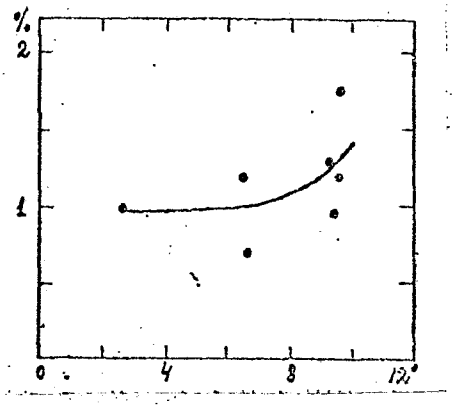

Figure 2. Polarization at the Center of the Jovian Disk as a Function of Phase Angle, %.

In the central portion of the planetary disk (see Figure 2) the polarization fluctuates from 0.70 to 1.75% and depends on the size of the diaphragm (see Table 1), which apparently is explained by the measurement of different regions of the planetary surface. However, according to the observations of Lyot [1], the polarization on the Jovian disk was identical within the limits of a large region in the center. /39

TABLE 1.

Phase Angle	Polarization, %	
	Diaphragm I (1″,52)	Diaphragm II (3″,03)
6°,4	1,20	0,80
6 ,6	0,70	0,80
9 ,3	1,30	1,40
0 ,5	1,75	0,50

For the central regions of Jupiter Lyot obtained an increase in the degree of polarization, depending on phase angle. According to our observations, in the phase angle interval of 3 to 7° the polarization remains almost identical, while with an increase in phase angle above 7° it begins to rise.

Lyot found that in the region of the polar caps the polarization attains a maximum value and does not depend on phase angle.

In 1952 Dollfus [2] found that the region of anomalous polarization was very large near the North Polar Region and very small at the South Polar Region. According to our observations (see Figure 3) it is possible to state

decisively that the region of anomalous polarization in 1964, just as in 1952, occurred at the polar regions; however, in contrast to the results of Dollfus, the polarization achieved a maximum value at the South Polar Region, where it remained almost constant with an increase in measured area (see Table 2). In the phase angle interval 2°.6-6°.6 the polarization increased from 8.2 to 9.4%, and subsequently fell sharply and attained a value of 4.9% at the phase angle 9°.5. As far as the North Polar Region is concerned, in this case the polarization decreased with an increase in measured area (see Table 3), while with an increase in phase angle it slowly decreased.

TABLE 2.

Phase Angle	Polarization, %	
	Diaphragm I (1″.52)	Diaphragm II (3″.03)
6°.4	9.0	9.6
6 .6	9.4	8.8
9 .5	4.9	5.7

TABLE 3.

Phase Angle	Polarization, %	
	Diaphragm I (1″.52)	Diaphragm II (3.″03)
6°.6	2.4	1.8
9 .5	1.8	1.4

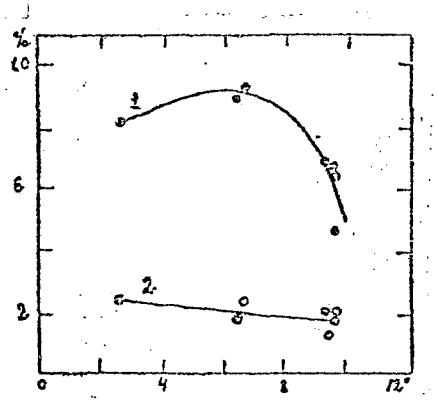

Figure 3. Polarization of the Polar Regions of Jupiter as a Function of Phase Angle, %: 1 - South Polar Region; 2 - North Polar Region.

Saturn /40

The polarization of the integral light of the visible disk of Saturn, just as for Jupiter, remains low. The maximum value of 0.5% is attained at a phase angle of 5.6 (see Figure 4). The polarization decreases up to a phase angle of 2.4 and then decreases noticeably with a subsequent increase in phase angle.

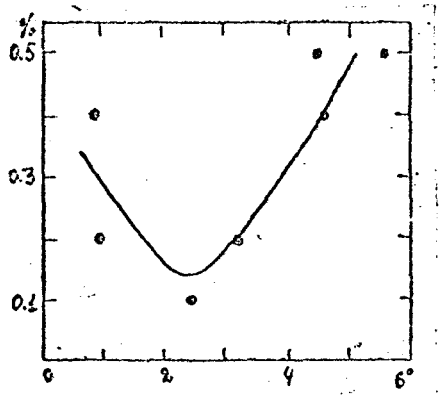

Figure 4. The Polarization of Integral Light from the Entire Disk of Saturn as a Function of Phase Angle, %.

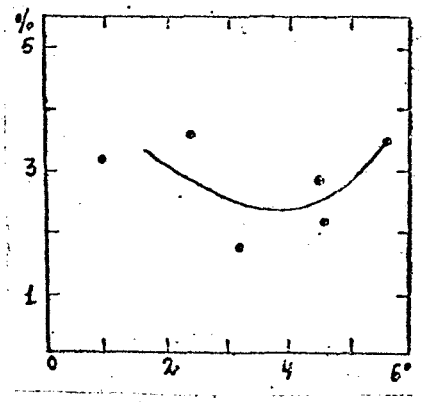

Figure 5. Polarization at the Center of the Disk of Saturn as a Function of Phase Angle, %.

Lyot [2] discovered a dependence of polarization on phase angle and the polarization was almost identical in the central portion of the disk of Saturn (about one-fourth in area). According to our observations (see Figure 5) the dependence of polarization on phase angle was also noted; however, the maximum polarization at the center of the disk attained a value of 3.6%, which exceeds by five times the maximum polarization value which Lyot observed.

The polarization of the polar regions of Saturn revealed a clear dependence on phase angle (see Figure 6), where similar to the case of Jupiter the south region has higher polarization than the north region, achieving a value of 11.7%.

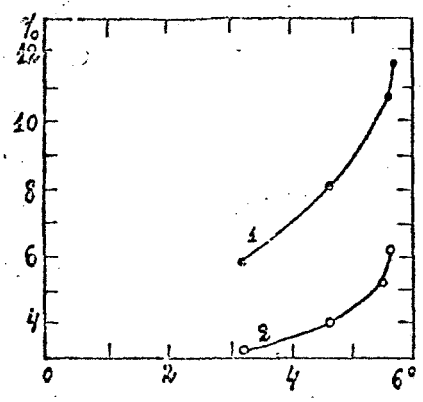

Figure 6. The Polarization of the Polar Regions of Saturn as a Function Phase Angle, %: 1 - South Polar Regions; 2 - North Polar Region.

Particularly high polarization values (up to 14-15%) were revealed by the eastern and western edges of the ring of Saturn (see Figure 7) and in this connection the western edge (1) always revealed higher polarization than the eastern edge (2). /41

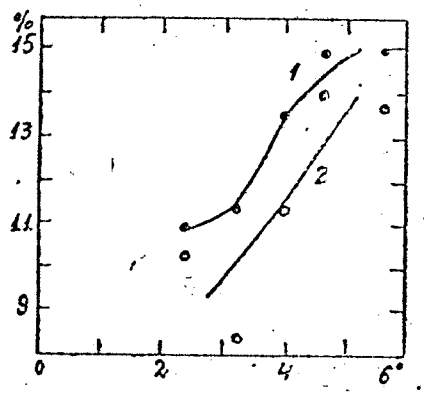

Figure 7. The Polarization on the Edges of the Ring of Saturn as a Function of Phase Angle, %: 1 - western edge of the ring; 2 - eastern edge of the ring.

The results obtained were based on observations during a short period of time (experimental work, alignment of equipment and observations). They will now be accomplished systematically and in greater detail.

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